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Authors' contributions
JW participated in the design of the study, performed the statistical analysis, and drafted the manuscript. JN conceived of the study, participated in its design, and provided revisions to the manuscript. Both authors read and approved the final manuscript.

Social inequality and visual impairment: a longitudinal study examining wealth and subjective social status as a risk factor for onset of visual impairment in older people in England.

ABSTRACT

Objectives: Visual impairment is the leading cause of age-related disability, but the social patterning of loss of vision in older people has received little attention. This study's objective was to assess the association between social position and onset of visual impairment, to empirically evidence health inequalities in later life. **Methods:** Visual impairment was measured in two ways: self-reporting fair vision or worse (moderate) and self-reporting poor vision or blindness (severe). Correspondingly, two samples were drawn from the English Longitudinal Study on Ageing (ELSA). First, 7483 respondents who had *good* vision or better at wave 1; second, 8487 respondents who had *fair* vision or better at wave 1. Survival techniques were used. **Results:** Cox proportional hazard models showed wealth and subjective social status were significant risk factors associated with the onset of visual impairment. The risk of onset of moderate visual impairment was significantly higher for the lowest and second lowest wealth quintiles, while the risk of onset of severe visual impairment was significantly higher for the lowest, second, and even middle wealth quintiles, compared with the highest wealth quintile. Independently, lower subjective social status was associated with increased risk of onset of visual impairment (both measures), particularly so for those placing themselves on the lowest rungs of the social ladder. **Discussion:** The high costs of visual impairment are disproportionately felt by the worst off elderly. Both low wealth and low subjective social status significantly increase the risk of onset of visual impairment.

Key words: longitudinal study, visual impairment, health inequalities, social determinants of health, wealth, subjective social status.

INTRODUCTION

Visual impairment is moving up the public health agenda: low vision is said to be the leading cause of age-related disability and with the ageing of society it is becoming an increasingly pressing issue (International Federation on Ageing, 2013). In the UK, an estimated 16 per cent of the over 50s population are visually impaired (defined as self-reported fair or worse vision) (Zimdars, Nazroo, & Gjonça, 2012), while 1 in 5 people over 75 living in private households reported difficulties with reading newsprint (Tate et al., 2005). While vision loss may be symptomatic of a number of age-related eye conditions, such as macular degeneration, diabetic retinopathy, cataracts, and glaucoma, a degree of reduced quality in vision is also expected with the normal ageing eye. The complex and far-reaching impacts of visual impairment are extensive both for the individual and for society (International Federation on Ageing, 2013). Deterioration in vision leads to negative effects on health and wellbeing for the individual (Mojon-Azzi, Sousa-Poza, & Mojon, 2008; Nyman, Dibb, Victor, & Gosney, 2012; Steinman & Allen, 2012; Zimdars et al., 2012); direct ophthalmologic costs, including screening and treatments from eye specialists (Salm, Belsky, & Sloan, 2006); direct non-ophthalmologic costs, such as in-home and nursing home caregiving (Berger & Porell, 2008); and indirect costs, for example the loss of productivity, absenteeism and premature retirement, and unpaid caregiving by others (Javitt, Zhou, & Willke, 2007; Zimdars et al., 2012).

Visual impairment in older people is an increasingly relevant area for public policy initiative, for two reasons. First, increasing life expectancy may result in increasing numbers of older, frail, and dependent people (Marmot & Nazroo, 2001). Second, the older population is diverse, with marked socioeconomic differences in morbidity and likely differences in the impact of illness according to an older individual's social circumstances (McMunn, Nazroo, & Breeze, 2009); thus, identifying and addressing social inequalities in onset of visual impairment (including social inequalities in the identification and treatment of eye disease) will be of increasing concern for public policy (Marmot & Nazroo, 2001).

Poor social and economic circumstances affect health throughout life. The effects of socioeconomic circumstances are not confined to the poorest in society, rather the social gradient in health runs right across society. Various theoretical explanations of the pathways and mechanisms underlying this inequality have been developed, with a number emphasizing both material circumstances and psychosocial stress as relevant factors. Marmot (2004; 2001) argues that the social gradient in health is explained not only by the direct effects of *absolute material deprivation* but also by the psychosocially mediated effects of *perceptions of relative disadvantage*. Material conditions alone do not explain health inequalities in rich countries; having met basic needs, consumption serves social, psychosocial, and symbolic purposes and health becomes also related to relative rather than absolute material conditions (Marmot & Wilkinson, 2001; McGovern & Nazroo, 2015). Consequently, it is important to consider both objective and subjective measures of socioeconomic position.

Cross-sectional analyses indicate that the prevalence of visual impairment is socially patterned (Ulldemolins, Lansingh, Valencia, Carter, & Eckert, 2012; Zimdars et al., 2012). A review of research on social determinants of visual impairment and blindness in the *general* population (Ulldemolins et al., 2012) reported that socioeconomic status was consistently inversely associated with the prevalence of visual impairment or blindness. However, social determinants of health in the older population have received relatively little attention, perhaps partly because measuring socioeconomic status in older age groups presents particular difficulties (French et al., 2012; Grundy & Sloggett, 2003). Only a small proportion of people over the age of 65 are in employment making classifications based on occupation problematic; income is also strongly associated with employment and decreases substantially once individuals leave the labor market; finally, education may be used as a proxy for socioeconomic status in studies of morbidity in older people because education mostly remains stable with age (Huisman, Kunst, & Mackenbach, 2003; Sundquist & Johansson, 1997); however, educational variables often only allow the most advantaged to be distinguished from the rest of the population as a substantial proportion of the current older population left school at minimum age with no academic qualifications (Grundy & Holt, 2001) and they are less reflective of current circumstances. Nevertheless, as older people account for the

majority of those in poor health, this would suggest a particularly compelling need to investigate social inequalities in health in later life (Grundy & Holt, 2001; Grundy & Sloggett, 2003). Also, a comprehensive review of research reveals a dominance of cross-sectional analyses of associations between risk factors and the *prevalence* of a visual impairment, which may not be a good estimate of possible causal associations: reasons for leaving work early may be health related and poor health may be associated with downward social mobility towards the end of working life (Grundy & Holt, 2001; Kom, Graubard, & Midthune, 1997). Causal mechanisms underpinning visual impairment can be more convincingly identified using longitudinal data.

Using longitudinal data, the aim of this study is to measure socioeconomic inequalities in the risk of onset of visual impairment in the older population in England using both an objective (wealth) and a subjective (subjective social status) indicator, having controlled for the effects of a number of other social, behavioral, and medical factors. Disentangling the mechanisms giving rise to increased risk of the onset of visual impairment in the older population is crucial for the development of appropriate policies to alleviate such inequalities; appropriately targeted intervention, increasing early detection of potentially treatable impairment (for example, refractive errors and cataracts through spectacle correction and surgery) would therefore improve population health and reduce the individual and societal costs associated with visual impairment (Ploubidis, DeStavola, & Grundy, 2011).

METHODS

The English Longitudinal Study of Ageing (ELSA) contains detailed information on the health, economic, and social circumstances of the population aged 50 and over in England (Steptoe, Breeze, Banks, & Nazroo, 2012). ELSA began data collection in 2002 and has continued to track the same individuals every 2 years; this study uses data from waves 1 to 5 of ELSA, collected over an 8-year period. The baseline sample of ELSA comprises 11,391 individuals (Table 1). The core ELSA sample was selected from households that responded to the Health Survey for England (1998, 1999, 2001), which

is representative of private households nationally. Households were issued to field if they included at least one person aged 50 and over (who, according to administrative records, remained alive) and had indicated they were willing to be re-contacted in the future. This sampling strategy introduces the potential for non-response at two stages; during the collections of the HSE data and when drawing the ELSA sample from the HSE. Individual response rates to both the HSE and ELSA (wave 1) are relatively good varying between 67% and 70% for the three HSE datasets and attaining 67% in ELSA. The HSE samples are considered sufficiently representative of the target population (private household population in England) that non-response weights were not created. Non-response weights are calculated and provided at each wave of ELSA to deal with survey non-response and are used in the analysis (Taylor et al., 2007). As the research involved the analysis of a secondary data source, the authors did not require ethical approval. At the time of data collection however ethical approval for all the ELSA waves was granted from the National Research and Ethics Committee. Informed consent was gained from all participants.

Assessment of visual impairment

ELSA uses a self-report measure of vision to assess visual function. The following question was asked at each of the 5 waves of data collection: *Is your eyesight (using glasses or corrective lenses as usual) excellent, very good, good, fair, or poor?* An additional response, registered blind, was included where respondents spontaneously provided this answer. This was used to define two binary response variables; first, *moderate* visual impairment is defined as self-rated eyesight of fair, poor, or blind and, second, *severe* visual impairment as self-rated eyesight of poor, or blind. These two response variables are intended to represent a less strict and a stricter measure of visual impairment and are created by moving the threshold of what is considered normal vision. For the analysis, visual impairment (whether moderate or severe) is treated as an event in a series of observations where the respondent reports that their eyesight has fallen below the defined threshold; the same hypothesis are maintained for both of the visual impairment categories and analyses are simply repeated using both measures. We present findings from

both sets of analysis to test whether the results are the product of where we chose to draw the threshold between visual impairment and normal vision.

ELSA does not include a clinical measure of visual acuity; however, comparisons of objective and subjective measures of vision do show reasonable validity of the self-report measure as an indicator of visual acuity (Laitinen et al., 2005; Whillans & Nazroo, 2014; Zimdars et al., 2012). Analysis of the Irish Longitudinal Study on Ageing, which contains both self-reported vision and objectively measured visual acuity (logMAR), showed that almost all of those with normal visual acuity (> 0.5 logMAR in the better-seeing eye) were correctly identified by the self-report measure (91.5% specificity) and almost all of those who self-reported normal vision measured with normal visual acuity (97.1% negative predictive value). However visual impairment appears over estimated in the self-report data so some caution in taken in interpreting models as they will likely underestimate the size of effects as a consequence of some of those with normal visual acuity self-reporting visual impairment (Whillans & Nazroo, 2014).

Sample

Two samples were created, corresponding with the two (less strict and stricter) measures of visual impairment. For the first, of the initial 11,391 core respondents to ELSA, respondents were excluded if in wave 1 there was item non-response to the question on self-reported vision (N=7) or if they reported already having moderate visual impairment (fair vision or worse), i.e. the event being examined had already occurred (N=1865). It was also necessary for a response to be given in wave 2 to the question on vision; due to survey non-response rather than item non-response, this excluded a further 2036 respondents. In drawing the second sample, to re-run the models with the stricter measure of visual impairment, respondents were excluded if in wave 1 there was non-response to the question on self-reported vision (N=7), if they reported severe visual impairment in wave 1 (poor vision or blindness) (N=472), and if there was non-response at wave 2 (N=2425), which again was due to survey rather than item non-response. The final analytical samples comprised of 7483 respondents for the analysis of the less

strict indicator, moderate visual impairment, and 8487 respondents for the analysis of the stricter measure, severe visual impairment. In both samples, the highest wealth quintile was slightly over-represented and the lowest quintile under-represented, which is a facet of the exclusionary criteria which required respondents to enter the study with normal vision (Table 1).

[Table 1]

Assessment of social position

First, wealth was used as a measure of material inequalities. The wealth variable reflects the value of all financial and physical assets at the disposition of the household: it was measured in net total non-pension wealth at the benefit unit level, which includes the value of the primary house minus the outstanding primary house mortgage, the value of savings and shares minus credit card debts and loans, and the value of other properties and businesses. Wealth may be said to reflect command over material resources, reflects accumulated advantage and future economic prospects, and is argued to lie in the core of material inequalities in health (Demakakos, Nazroo, Breeze, & Marmot, 2008; Oliver & Shapiro, 1997). Furthermore, unlike education and occupational class, wealth reflects the contemporary socioeconomic status which is a more appropriate measure for use in older people. Wealth is a relatively stable variable over the observation period whereas income is liable to significantly change once older people retire and leave the labor force. Compared with income, wealth is potentially less sensitive to the differences in material circumstances between individuals who do not own their own home; however, accumulated wealth is in an important part of a household's economic resources and can be drawn upon to protect individuals from economic hardship and vulnerability. Wealth at baseline was entered into the model as quintiles with the highest wealth quintile as the reference group.

In addition to examining the effects of material circumstances (using wealth) on vision we also examined subjective social status (SSS), which refers to the individual's perception of his own position in

the social hierarchy (Jackman & Jackman, 1973). SSS was measured using a scale graphically represented by a 10-rung ladder accompanied by the instruction: "Think of this ladder as representing where people stand in our society. At the top of the ladder are the people who are the best off – those who have the most money, most education and best jobs. At the bottom are the people who are the worst off – who have the least money, least education, and the worst jobs or no jobs. The higher up you are on this ladder, the closer you are to the people at the very top and the lower you are, the closer you are to the people at the very bottom. Please mark a cross on the rung on the ladder where you would place yourself". SSS is argued to reflects the cognitive averaging of one's objective status positions and while also capturing more subtle differences in status hierarchy than standard objective economic measures (Singh-Manoux, Adler, & Marmot, 2003). The SSS measure is arguably be more sensitive to such distinctions providing an 'added value' to objective measures. The SSS 10-item scale was recoded into a 5-item scale; respondents marking the bottom 2 rungs of the ladder perceive themselves to be the 'worst off' in society, those marking rungs 3 and 4 as the lower-middle, rungs 5 and 6 as the middle, rungs 7 and 8 as upper middle, and those marking rungs 9 and 10 perceive themselves to be the 'best off' in society. The highest SSS category was used as the reference group. Wealth and SSS are used together to capture the effects of material and subjective perceptions of social position on the risk of onset of visual impairment.

Assessment of other covariates

Demographic variables included age (grouped into 5-year bands so that non-linear effects could be examined) and gender. Models were adjusted for the effects of medical factors on the onset of visual impairment using measures of health behaviors and diagnoses at baseline (wave 1), including smoking (never smoked, used to smoke, smokes nowadays), diagnosed diabetes, and diagnosed hypertension.

Data analysis

Survival analysis techniques were performed using Stata, version 12.1. Analyses were repeated with both samples and all analyses were conducted using wave 2 weights adjusting for survey non-response (all respondents had wave 2 weights, but did not necessarily participate beyond this point). Details of the derivation of this weight are detailed in the Wave 2 Technical Report (http://www.ifs.org.uk/elsa/). First, life tables were calculated using Kaplan-Meier estimates to describe the distribution of event occurrence over time. All respondents were considered at risk of visual impairment until the occurrence of an observation of impairment, a censoring event, or the final wave of observation. Kaplan-Meier survival curves were examined to make univariate comparisons of discrete groups of respondents, for all the categorical predictors. Cox regression-based tests were then performed as a statistical evaluation for the equality of survival curves and as an indicator of the suitability of each variable for inclusion in subsequent models (rather than using logrank tests as data were weighted); predictors were considered for inclusion if the test had a p-value of 0.2 or less. This univariate analysis was supplemented by basic descriptive statistics to examine the distribution of the outcome variables among all respondents.

Second, Cox proportional hazards models were used to analyze the effects of social position on the risk of onset of visual impairment while controlling for the effects of a number of other potentially significant risk factors. Starting with a null model, predictors were entered incrementally into the model; nested models were compared using likelihood ratio tests to assess to overall contribution of the newly entered set of variables. The final models included age at baseline (grouped in 5-year bands), wealth (quintiles), SSS (5-item scale), health behaviors (smoking), and medical diagnoses (diabetes and hypertension). Estimates were derived for the hazard ratio and the 95% confidence intervals (CI) for the relation between social position and the onset of visual impairment, while adjusting for other risk factors.

RESULTS

When modelling the onset of visual impairment using the less strict measure (moderate visual impairment) and using the corresponding smaller sample of 7483, a total of 1600 reported the onset of

moderate visual impairment, 3559 did not experience moderate visual impairment during the study, and 2324 respondents dropped out of the study at some point during the 8-year observation period without first having reported moderate visual impairment (Table 2). The probability of not experiencing moderate visual impairment was 0.739; thus, the probability of self-reporting fair vision, poor vision or blindness was 0.261. Likewise, when modelling the onset of visual impairment using the stricter measure and using the second sample, 501 respondents reported the onset of severe visual impairment, 4870 did not experience visual impairment during the study period, and 3116 dropped out of the study without having first reported visual impairment. The overall probability of not experiencing severe visual impairment was 0.923; correspondingly, the probability of reporting the onset of poor vision or blindness was 0.077. Of the 1600 reporting moderate visual impairment, around one third had a diagnosed eye condition (N=531, 32.8%); while around half of all respondents reporting severe visual impairment had a diagnosed eye condition (N=262, 51.6%) (Table 3). Of the respondents reporting onset of visual impairment and an eye condition, cataracts were the most common diagnosis: 20.6% of respondents reporting onset of moderate visual impairment and 27.7% of respondents experiencing onset of severe visual impairment had a cataract diagnosis.

[Table 2]

[Table 3]

Descriptive analyses show that with increasing age the risk of visual impairment increases, as expected, incrementally at the younger ages and more rapidly into the older age bands, which is evident across both the less strict and stricter measure of visual impairment (Table 4). Furthermore, the onset of visual impairment was associated with both material and subjective socioeconomic indicators (Table 4). When analyzing both the moderate and severe measures of visual impairment, respondents in the lower wealth quintiles were the most likely to report the onset of visual impairment. Almost a quarter of respondents in

the second wealth quintile (24.7%) and almost a third of those in the poorest wealth quintile (32.3%) reported onset of moderate visual impairment compared with one in six (16.0%) in the wealthiest quintile. When examining the stricter measure, severe visual impairment, the poorest quintile was and almost 3 times more likely to report onset compared with the highest wealth quintile (10.4% compared with 3.6%).

[Table 4]

Respondents' perception of their relative social standing also appeared to have a strong relationship with the onset of visual impairment for both the less strict and stricter measures. Those who feel that they are among the worst off were 1.4 times as likely to report the onset of moderate visual impairment, even compared with those in the second SSS category, (36.8% compared to 26.8%) and 1.8 times as likely to report severe visual impairment (7.3% compared to 3.4%). Compared with those who perceive themselves to be the best off in society, those seeing themselves as the worst off were 2.4 times as likely to report the onset of moderate visual impairment (15.2% and 36.8%) and 2.4 times as likely to report onset of severe visual impairment (5.6% and 13.4%).

Kaplan-Meier curves show the proportion over time of respondents experiencing the onset of moderate visual impairment and severe visual impairment by wealth quintile (top) and, separately, by SSS category (bottom) (Figure 1). Looking at the distribution of event occurrence, it is again seen that those in the lowest wealth quintiles have a lower probability of survival from visual impairment, which is seen in both measures (Cox regression-based test $P \leq 0.000$, $P \leq 0.000$ respectively). The risk of onset of visual impairment appears even more pronounced for those who perceived themselves to be among the worst off in society as seen in the Kaplan Meier curves by SSS category (Cox regression-based test $P \leq 0.000$, $P \leq 0.000$).

[Figure 1]

Multivariate Cox proportional hazard models were used to estimate independent associations between predictor variables and onset of visual impairment. Likelihood ratio tests comparing nested models showed that gender, age, wealth, SSS, and health conditions and behaviors each made a significant contribution to the overall explanatory power of the models for both measures of visual impairment; therefore, all variables were included in the final models.

[Table 5]

Table 5 shows that the risk of the onset of visual impairment is greater for women than men. While this is statistically significant for the measure of moderate visual impairment (females 1.164**), it was not for the stricter measure, severe visual impairment, even though the coefficient was larger (females 1.199). Age was also related to onset of visual impairment, significantly so compared to the youngest age band from age 65 for moderate visual impairment and from age 60 for severe visual impairment. For both measures of visual impairment, being a smoker increased the risk of onset compared to those who had never smoked (1.481*** for moderate visual impairment and 1.675*** for severe visual impairment), while those who had given up smoking did not have a greater risk. Diabetes and hypertension were both associated with a greater risk of both onset of visual impairment (respectively for moderate visual impairment 1.442*** and 1.190*** and for severe 1.443* and 1.206*).

After controlling for the effects of other predictor variables, the effects of material circumstances and perceived social standing on the risk of onset of visual impairment were evident. When examining the less strict measure of visual impairment, the risk of onset was found to be significantly higher for the second and lowest wealth quintiles compared with the highest wealth quintile (1.319** and 1.585*** respectively). Holding all else constant, including wealth, SSS was also a significant predictor of onset of visual impairment; those identifying themselves as being in the middle, lower-middle, and among the

worst off had a significantly higher risk of onset of moderate visual impairment compared with those who perceive themselves to be the best off (1.346*, 1.526**, and 2.092*** respectively).

Wealth and SSS were also statistically significant predictors of the onset of severe visual impairment in the fully adjusted models. The poorest, second, and even middle wealth quintiles had significantly higher probabilities of onset of visual impairment compared with the highest wealth quintile (1.793***, 1.508*, and 1.490*) while those perceiving themselves to be among the worst off in society having a significantly higher risk of onset (1.792*).

DISCUSSION

Multivariate Cox proportional hazard models revealed that material wealth and subjective social status (SSS) were, in a model that adjusted for other factors and each other, significant predictors of the onset of both moderate and severe visual impairment, The poorest older people were 1.6 times more likely to experience the onset of moderate visual impairment (Hazard Ratio (HR) 1.585***) and 1.8 times more likely to experience the onset of severe visual impairment (HR1.793***), compared to the wealthiest. Similarly, holding all else constant, perceiving yourself to be among the worst off in society was associated with increased risk of onset of moderate visual impairment (HR 2.092***). Importantly, the effects of these socioeconomic factors run right across society. For example, those in the second lowest and middle SSS categories were also at a significantly greater risk (HR 1.526** for onset of moderate visual impairment and 1.346*for severe). While the findings in this study show the effect of prior social position on experiencing visual impairment in models with controls for several other variables, including relevant medical conditions, there are other factors that may have confoundd the relationship, such as cognition, and non-cognitive abilities.

A number of limitations exist in using ELSA for the analysis of the onset of visual impairment. First, it is not uncommon for longitudinal data to have missing values or for respondents to leave the study; attrition is a particularly acute issue in a longitudinal study of older people as respondents are

increasingly likely to leave the study due to poor health, cognitive impairment, institutionalization, or death. Those who continue in ELSA in wave 2 and beyond are generally healthier, wealthier, and more socially connected than those who dropped out. Although wave 2 weights were used to correct for this non-response, it is possible that the weighting does not correct for all sources of bias (Shankar, McMunn, Banks, & Steptoe, 2011).

Second, clinical measures of visual acuity are not collected as part of ELSA, an important shortcoming of this secondary data source. Arguably, self-reported visual function may be a more accurate assessment of older peoples visual functioning as it is likely to reflect vision under the non-optimal viewing conditions encountered in daily life (Brabyn, Schneck, Haegerstrom-Portnoy, & Lott, 2001; Haegerstrom-Portnoy, Schneck, & Brabyn, 1999); however, self-reported vision will also, inevitably, reflect more than visual acuity. Despite this, evidence suggests that self-reported vision measures used here have reasonable validity (Whillans & Nazroo, 2014; Zimdars et al., 2012).

The analysis presented in this paper highlights the magnitude of health inequalities experienced by older people in England. In addition to the direct causal effects perhaps mediated by stress pathways, this may relate to the identification and treatment of refractive errors and eye disease. Although refractive error can often be corrected by the use of spectacles, contact lenses, or refractive surgery, it is frequently not addressed in the population at large and is a leading cause of visual impairment (Congdon et al., 2004; Midelfart, Kinge, Midelfart, & Lydersen, 2002). In a US study of adults aged 40 and over, the most common reason given for not seeking eye care among those with visual impairment was cost or lack of insurance (Centers for Disease Control Prevention, 2011). Also in the UK, level of income was found to be a significant barrier to regular eye tests in older people, with those in lower income brackets disproportionately dissuaded by the potential subsequent cost of glasses (Conway & McLaughlan, 2007). The findings in this study may therefore indicate is that the poorest (wealth) and those who perceive themselves to be the worst off in society are at greater risk of *experiencing* vision loss to the point of visual impairment as a consequence of not having regular eye examinations and the most current and correct prescription in their glasses or lenses. Removing financial barriers to regular eye examinations

would reduce inequalities in the likelihood of early identification and treatment of refractive errors and eye disease. A case in point is the lack of socioeconomic inequalities in the use of general practice (GP) services among older people: in the absence of a financial barrier, as under the UK National Health Service, contact rates with GPs were 14% higher and home visiting rates 109% higher in older people in social class V than in those from class I (McNiece & Majeed, 1999). Making optometry services more readily available outside of a retail sector may reduce social inequalities in uptake of eye care services and treatment.

The findings in this study may seem to have limited applicability to the US given the notable differences between healthcare systems in England and the US. In England, routine eye exams to the over 60s and medical treatment are publically funded, and service provision is not related to an ability to pay at the point of delivery. In the US, healthcare is funded by a combination of public and private insurance. Generally speaking, Medicare does not cover routine vision services like eye exams and glasses; it only covers eye care services if a chronic eye condition is suspected or has been diagnosed, glaucoma screening for those considered high risk, and surgical procedures (e.g. cataract surgery); however, recipients are required to pay a contribution, creating a significant point-of-service fee for many users. Given the patchwork of public and private insurance in the US and the coverage offered by Medicare, those who perceive themselves to be among the worst off and those who least able to afford comprehensive health insurance or point-of-service fees may be more likely to live with uncorrected refractive errors and undiagnosed (yet detectable and treatable) eye conditions. Thus, if the potential financial cost of glasses constitutes a significant barrier to the uptake of a free eye exam and individuals' self-management of eye care in England, manifesting itself in systematic and empirically-evidenced social inequalities in the onset of visual impairment, this may suggest that the relationship between material and psychosocial factors indicating social position and visual impairment may be even stronger in the US. The findings from this study invite further research into the effects of social inequalities, and it's interrelationship with healthcare provision, on the eye health and the onset of visual impairment in older people in the US.

CONCLUSION

The study indicated that the burdens of visual impairment are felt disproportionately by those who are already socially disadvantaged. Socioeconomic inequalities at baseline (that is, inequalities existing *prior to* the onset of visual impairment) were found to be associated with increased risks of onset of visual impairment. Identifying the association between low social position and the onset of visual impairment provides additional emphasisto the need to address socioeconomic inequalities and should inform health campaigns and the promotion of aids, services, and treatments (Margrain, 1999), to successfully target those most at risk of visual impairment, and thus reduce the extensive and complex direct and indirect, financial and social costs of visual impairment in older people.

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Table 1 Characteristics of original (left), moderate visual impairment (middle) and severe visual impairment (right) samples

	Core sample (N=11,391)		**Moderate visual impairment sample** (N=7483)		**Severe visual impairment sample** (N=8487)	
	N	(col) % weighted*	N	(col) % weighted**	N	(col) % weighted**
Gender						
Male	5,186	46.4	3,427	47.1	3,837	46.4
Female	6,205	53.7	4,056	52.9	4,650	53.6
Age group (yrs)						
50 - 54	1,981	19.4	1,423	21.3	1,580	20.8
55 - 59	2,185	17.9	1,524	19.0	1,702	18.7
60 - 64	1,688	14.8	1,209	16.1	1,327	15.6
65 - 69	1,710	13.6	1,192	14.4	1,316	14.0
70 - 74	1,471	12.3	955	12.2	1,095	12.3
75 – 79	1,094	10.2	640	9.2	762	9.6
80 plus	1,262	11.8	540	7.8	705	9.0
Wealth quintile						
Highest	2,302	19.6	1,741	22.0	1,869	20.8
Fourth	2,235	19.6	1,643	21.6	1,794	20.8
Middle	2,236	19.6	1,499	20.0	1,683	19.7
Second	2,241	19.6	1,367	18.4	1,614	19.2
Lowest	2,177	19.7	1,119	16.4	1,390	17.9
Missing	200	1.8	114	1.6	137	1.7
Subjective social status category						
Highest	462	4.1	351	4.5	379	4.3
Fourth	3,056	26.7	2,303	29.9	2,492	4.3
Middle	4,571	39.9	3,240	43.3	3,634	28.5
Second	1,826	16.1	1,097	15.2	1,345	42.7
Lowest	455	4.0	244	3.4	310	16.4
Missing	1,021	9.4	248	3.6	327	0.0
Smokes						
Never smoked	4,019	35.3	2,783	36.9	3,094	36.2
Used to smoke	5,367	47.0	3,468	45.9	3,952	46.0
Smokes nowadays	2,005	17.7	1,232	17.3	1,441	17.8
Diabetes						
No	10,543	92.7	7,036	94.1	7,942	93.6
Yes	848	7.3	447	5.9	545	6.4
Hypertension						
No	7,078	62.5	4,763	63.9	5,322	62.9
Yes	4,313	37.5	2,720	36.1	3,165	37.1
Self-reported vision						
Excellent	1,681	14.8	1,378	18.2	1,378	16.0
Very good	3,449	30.2	2,706	35.9	2,706	31.5
Good	4,389	38.4	3,399	45.9	3,399	40.3
Fair	1,393	12.2			1,004	12.2
Poor	416	3.8				
Blind	56	0.5				
Missing	7	0.1				

* using wave 1 core members non-response weight, **using wave 2 core members non-response weight

Table 2 Distribution of event occurrence, respondents lost to follow up, and survival from visual impairment between waves 1-5

Time	Wave Interval	Total remaining sample	Onset of visual impairment	Lost to follow up	Survivor Function weighted	Survivor Function unweighted	[95%	Conf. Int.]
Moderate visual impairment								
1	w1-w2	7483	668	1131	0.908	0.911	0.904	0.917
2	w2-w3	5684	435	771	0.837	0.841	0.832	0.850
3	w3-w4	4478	300	422	0.781	0.785	0.774	0.795
4	w4-w5	3756	197	-	0.739	0.744	0.732	0.755
Severe visual impairment								
1	w1-w2	8487	181	1449	0.977	0.979	0.975	0.982
2	w2-w3	6857	132	1045	0.957	0.960	0.955	0.964
3	w3-w4	5680	102	622	0.939	0.943	0.937	0.948
4	w4-w5	4956	86	-	0.923	0.926	0.920	0.932

Table 3 Proportion of respondents reporting moderate (left) and severe visual impairment (right) with diagnosed eye conditions

	Moderate visual impairment		**Severe visual impairment**	
	N	(col) % weighted	N	(col) % weighted
Diagnosed eye condition	**531**	**32.8**	**262**	**51.6**
Glaucoma	70	4.3	29	6.1
Diabetic eye disease	16	1.1	9	1.7
Macular degeneration	50	3.0	32	6.6
Cataracts	334	20.6	142	27.7
Multiple eye conditions	61	3.7	50	9.5
No eye conditions	**1063**	**66.8**	**231**	**46.8**
Missing	6	0.4	8	1.6

Table 4 Percentage of respondents in the moderate (left) and severe visual impairment (right) samples experiencing visual impairment

	Moderate visual impairment		**Severe visual impairment**	
	N	(row) % weighted	N	(row) % weighted
Gender				
Male	649	19.0	182	4.9
Female	951	24.0	319	7.3
Age group (yrs)				
50 - 54	223	15.4	39	2.3
55 - 59	232	15.6	49	3.2
60 - 64	217	18.1	52	4.0
65 - 69	255	21.6	62	4.7
70 - 74	257	27.1	99	9.3
75 – 79	211	32.8	87	11.3
80 plus	205	38.9	113	17.0
Wealth quintile				
Highest	271	16.0	65	3.6
Fourth	288	17.7	72	4.2
Middle	311	20.8	100	6.2
Second	340	24.7	113	7.1
Lowest	368	32.3	144	10.4
Missing	22	19.3	7	5.3
Subjective social status category				
Highest	52	15.2	21	5.6
Fourth	356	15.8	85	3.7
Middle	727	22.6	197	5.6
Second	298	26.8	101	7.3
Lowest	92	36.8	43	13.4
Missing	75	30.7	54	18.0
Smokes				
Never smoked	548	20.3	170	5.9
Used to smoke	719	20.9	223	5.8
Smokes nowadays	333	26.6	108	7.6
Diabetes				
No	1,464	21.1	450	5.9
Yes	136	30.9	51	9.7
Hypertension				
No	912	19.4	267	5.2
Yes	688	25.6	234	7.7

Table 5 Cox proportional hazards models of the onset of moderate (left) and severe visual impairment (right)

	Onset of moderate visual impairment		**Onset of severe visual impairment**	
	HR	95% CI	HR	95% CI
Gender				
Male	1		1	
Female	1.164**	(1.053 - 1.287)	1.199	(0.989 - 1.452)
Age				
52 – 54	1		1	
55 – 59	0.993	(0.827 - 1.192)	1.373	(0.895 - 2.108)
60 – 64	1.203	(0.998 - 1.449)	1.785**	(1.172 - 2.720)
65 – 69	1.413***	(1.180 - 1.691)	2.132***	(1.418 - 3.205)
70 – 74	1.802***	(1.507 - 2.154)	4.185***	(2.863 - 6.119)
75 – 79	2.327***	(1.933 - 2.802)	5.164***	(3.501 - 7.616)
80 +	3.165***	(2.617 - 3.829)	9.302***	(6.335 - 13.658)
Wealth quintile				
Highest	1		1	
Fourth	1.048	(0.890 - 1.234)	1.160	(0.820 - 1.639)
Middle	1.167	(0.990 - 1.375)	1.490*	(1.066 - 2.083)
Second	1.319**	(1.118 - 1.555)	1.508*	(1.087 - 2.092)
Lowest	1.585***	(1.336 - 1.881)	1.793***	(1.295 - 2.484)
Missing	1.271	(0.858 - 1.883)	1.509	(0.707 - 3.221)
SSS categories				
Highest	1		1	
Fourth	1.071	(0.811 - 1.415)	0.652	(0.402 - 1.058)
Middle	1.346*	(1.025 - 1.767)	0.752	(0.471 - 1.200)
Second	1.526**	(1.144 - 2.036)	0.947	(0.581 - 1.544)
Lowest	2.092***	(1.493 - 2.930)	1.792*	(1.033 - 3.107)
Missing	1.848***	(1.319 - 2.588)	2.087**	(1.230 - 3.540)
Smokes				
Never smoked	1		1	
Used to smoke	1.031	(0.923 - 1.152)	0.965	(0.787 - 1.182)
Smokes nowadays	1.481***	(1.292 - 1.698)	1.675***	(1.288 - 2.178)
Diabetes				
No	1		1	
Yes	1.442***	(1.215 - 1.713)	1.443*	(1.069 - 1.948)
Hypertension				
No	1		1	
Yes	1.190***	(1.078 - 1.314)	1.206*	(1.001 - 1.453)

* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Figure 1 Kaplan-Meier estimates for onset of moderate (left) and severe visual impairment (right) by wealth (top) and subjective social status (bottom)